Upper Truckee River Lahontan Cutthroat Trout Restoration Project

2013 Annual Report

USDA Forest Service, Lake Tahoe Basin Management Unit

Lahontan cutthroat trout, *Oncorhynchus clarkii henshawi*

Written by

Erin Miller (Biological Science Technician) and Maura Santora (Aquatic Biologist)

Reviewed by

Sarah Muskopf (Aquatic Biologist)

Reviewed / Approved by

Holly Eddinger (Forest Biologist / Biological Program Leader)

Contents

Executive Summary 2

Introduction 3

Methods 6

Results 8

2013 Field Work 8

2013 Genetic Information 15

2008 - 2013 Progress 15

Discussion 21

Conclusion 24

Literature Cited 24

Executive Summary

In 2013, the Lake Tahoe Basin Management Unit (LTBMU) continued implementation of the Upper Truckee River Lahontan Cutthroat Trout Restoration Project that began in 2008. Non-native trout were removed from approximately 2.7 km (1.7 mi) of the main stem of the Upper Truckee River (UTR) below Meiss Meadows, 1.7 km (1.1 mi) of the outlet tributary of Round Lake (RLT), and 2.0 km (1.2 mi) of the Showers Lake tributary (SLT) and another tributary that empties into the Showers Lake outlet tributary (0.63 km/ 0.39 mi). Removal efforts in Dardanelles Lake that was initiated in 2011 continued with the treatment of 18 lake acres and 1.8 km (1.1 mi) associated stream. An additional 3.2 km (2 mi) were surveyed in the RLT for future temporary barrier installation. In 2013, overall a total of 3,368 fish were sampled. Lahontan cutthroat trout (LCT; *Oncorhynchus clarkii henshawi*) captured in the project area totaled 737. Of these, 565 LCT were returned to the upper portion of the river, while 172 were removed from the lower portion of the project area due to potential hybridization with rainbow trout (*Oncorhynchus mykiss*). A total of 387 native speckled dace (*Rhinichthys osculus*) were returned to the river. All non-native species were removed, which included 2,244 brook trout (*Salvelinus fontinalis*).

Introduction

Historically, Lake Tahoe's fishery was dominated by a single predator, the Lahontan cutthroat trout (LCT). LCT were extirpated from Lake Tahoe by 1939 (Cordone and Frantz 1968, Moyle 2002). Several factors contributed to the extinction of LCT including over-fishing, logging, mining, dams, water diversions, intense grazing, road building, urban development, and the introduction of non-native fish and other aquatic organisms. These activities are believed to have cumulatively contributed to the change in Lake Tahoe's fish composition and degradation of fish habitat (Erman 1997, Murphy and Knopp 2000). LCT were listed as an endangered species in 1970 (Federal Register Vol. 35, p.13520). In 1975, under the Endangered Species Act of 1973 as amended, LCT was reclassified as threatened to facilitate management and to allow for regulated angling (Federal Register Vol. 40, p.29864).

Since the end of the 19th century, numerous non-native species have been introduced to water bodies in the Lake Tahoe basin, altering its biological assemblage. The non-native salmonid species found in Lake Tahoe and/or inlet streams include: rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), kokanee salmon (*Oncorhynchus nerka*), and lake trout (*Salvelinus namaycush*). Lake trout are currently found in Lake Tahoe, Fallen Leaf Lake, Stony Ridge Lake, and Gilmore Lake. The non-native warm water fish that have been documented to occur in Lake Tahoe inlet streams and near shore environment are: brown bullhead (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), and goldfish (*Carassius auratus*) (Kamerath et al. 2008). The presence of non-native fish has been found to disrupt the natural food webs, and to be negatively correlated with the distribution and abundance of native fish (Moyle and Nickols 1973, Betolli et al. 1992, Findlay et al. 2000, MacRae and Jackson 2001, Vander Zanden et al. 2003, Carey et al. 2011). Brook trout and brown trout compete with cutthroat trout for space and resources (Gerstung 1988, Gresswell 1988, Griffith 1988, Fausch 1989, Hilderbrand 1998, Schroeter 1998, Dunham et al. 1999). Rainbow trout, a closely related species, spawn at the same time and use the same spawning habitat as LCT with which it can interbreed creating hybrid individuals (Vander Zanden et al. 2003).

California Department of Fish and Wildlife (CDFW), in collaboration with LTBMU, reintroduced LCT from Macklin Creek into the headwaters of the Upper Truckee River (UTR) in Meiss Meadows in 1989 and 1990 initiating the reclamation of a total of 8 km (~5 miles) of stream and ~6 lake hectares (15 acres). Reclamation activities involved rotenone application, electro-fishing, and gillnetting to remove non-native brook trout from the UTR prior to LCT re-introduction. Since the initial reclamation activities, annual maintenance removal efforts occurred in Meiss Meadows until 2009, after three consecutive years of no non-natives observed. Since 2009, the Meiss Meadow population has been allowed to recover from sampling and electro-shocking effects. CDFW currently monitors the success of brook trout removal efforts through voluntary angler reporting. The LCT population in Meiss Meadows is currently one of the only high-elevation self-sustaining populations of LCT found in meadow habitat in the Sierra Nevada mountain range.

In 2008 the LTBMU began implementation of the Upper Truckee River (UTR) Lahontan Cutthroat Trout Restoration Project downstream of the Meiss Meadow area. The project area encompasses 16 km (10 miles) of perennial stream and ~34 hectares (85 acres) of lake habitat within the UTR watershed (Fig. 1), and is referred to as the "Expansion Area". The objective of the effort was to facilitate natural range expansion of the Meiss Meadows LCT population downstream by removing non-native trout. The project will reclaim additional stream habitat for federally threatened LCT in the UTR. The project is in California (El Dorado County) on National Forest System land within the LTBMU and is entirely in the Meiss Management Area (USDA 1988).

Reclaiming aquatic habitat in the UTR watershed is consistent with CDFW goals and objectives for recovering and developing waters for native salmonid fisheries. The CDFW currently works under the interagency Fishery Management Plan for Lahontan Cutthroat Trout in California and Western Nevada Waters (Gerstung 1986), which identifies the UTR as a priority area in Lake Tahoe to reclaim aquatic habitat for LCT. Additionally, the UTR and tributaries upstream of the confluence with Showers Lake drainage are designated by the California Fish and Game Commission as a Heritage and Wild Trout Water for a self-sustaining population of LCT within their historic (native) drainages.

Restoration efforts in the expansion area were approved by the U.S. Fish and Wildlife Service (USFWS) in the 2008 Biological Opinion (BO; File #: 2008-F-0434-BO). During the 2010 field season, re-initiation of consultation was conducted and an amended BO (file #: 2008-F-0434-R001) was received in October 2010. The amended BO allowed for the removal of LCT where potential hybridization with rainbow trout was anticipated. The LTBMU and USFWS agreed that in the interest of LCT recovery in the Lake Tahoe basin, genetically pure populations of LCT within the expansion area is the desired goal. This annual report is prepared in part to meet the requirements in the BO (#2008-F-0434-R001) for reasonable and prudent measures on the progress of the LCT restoration project.

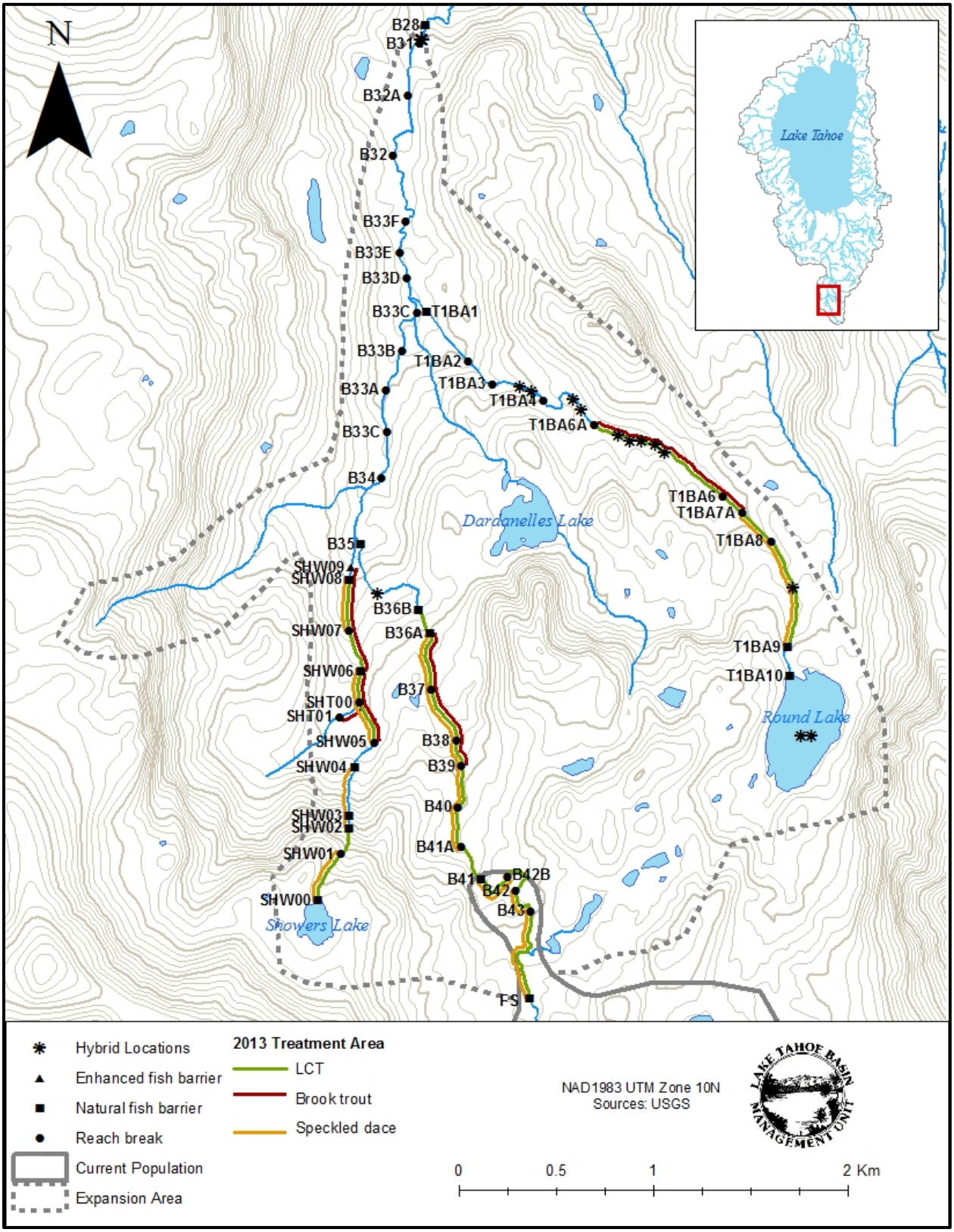


Figure 1. The Lake Tahoe Basin Management Unit (LTBMU) Upper Truckee River Lahontan Cutthroat Trout Restoration Project 2013 treatment area

Methods

The LTBMU Aquatics Crew manually removed non-native trout and selected LCT by electro-fishing methodology - "Guidelines for Electro-fishing Waters Containing Salmonids Listed under the Endangered Species Act" (NMFS 2000) was used to develop the protocol. A three-pass depletion method was planned to enable tracking of non-native trout removal progress on a site-specific basis. Three-pass depletion relies on barriers to prevent the recapture of the same fish during multiple passes. Natural low water fish barriers (i.e. waterfalls, chutes, cascades) were identified in 2008 before implementation of the project, and were used to delineate the river into treatment reaches. If a reach contained no non-native trout on the first pass, only one pass was conducted. If non-native trout were detected, 3-pass depletion was initiated. The barriers used in 2013 were the same as those used in previous years (Fig. 1), so that progress could be compared annually. Throughout implementation, fish sampled were identified and measured into size classes. Non-native trout and LCT that were removed based on hybridization concerns were also sexed. Above barrier 36B on the main stem of the UTR and above barrier SHW09 in the Showers Lake Tributary (SLT) (Fig. 1), all LCT and speckled dace (*Rhinichthys osculus*) were relocated upstream to previously treated reaches and brook trout were removed from the river. In the Round Lake Tributary (RLT), all salmonids were removed above barrier T1BA6A due to hybridization risk. RLT was the only stream where LCT were removed in 2013.

In 2013 the LTBMU Aquatics Crew was assisted by field crews from partner agencies CDFW and Trout Unlimited, along with volunteers from the University of Nevada at Reno student chapter of the American Fisheries Society and Trout Unlimited. Partner crews and volunteers contributed a total of 486 hours to the project. These efforts allowed the LTBMU Aquatics Crew to repeat the method of 3-pass depletion several times on select reaches in the project area and to treat more stream length than has been possible in the past . For example, in 2012 one 3-pass depletion was completed on the RLT from T1BA7A to T1BA1 and from B38 to B36B on the UTR (Figure 1). The remainder of the RLT and the UTR above these uppermost barriers were surveyed with a single-pass depletion (because no non-native trout were detected). Although 7.4 km (4.6 miles) were treated in 2012, multi-depletions were not feasible as in 2013. These multi-depletions (repeated 3-passes) are effective in recovery efforts intending to eradicate waters of non-native fishes (Pers. Comm. Bill Sommer, CDFW; Pers. Comm. John Hancock, CDFW; Pers. Comm. Chad Mellison, USFWS).

Two backpack electro-fishers were used for survey efforts; a Smithroot LR-24 and a Smithroot LR-20B. The electro-fishers were set between 300-500 volts and 30-60 hertz for all reaches. These settings are not standard but worked effectively with the typical electric conductivity and turbidity of the expansion area drainages. Fish recovered quickly in most instances. Electro-fisher settings were adjusted as needed and recorded when changed. Electro-fishing crews (3 people per crew) implemented removal treatments from the fourth week in July through the end of September. To increase efficiency and productivity, crews conducted passes on a single reach with one crew beginning approximately 20 to 30 minutes prior to the second crew. Upon completion, one crew would initiate survey efforts on the next reach while the other crew completed the third pass.

On the UTR, reaches between barriers B39 and FS (1.8 km, 1.1 mi) were treated with single pass methods because no non-native salmonids were detected on the first pass. Reaches upstream of

B41 were surveyed in 2013 as a monitoring effort to ensure the absence of non-native trout and that the current population of LCT is stable. The remaining 4 reaches (0.9 km, 0.6 mi) from barrier B36B to B39 were treated with seven to nine additional passes.

In RLT, the reach above T1BA9 was dry when implementation activities were initiated. A single pass treatment occurred above T1BA8 (0.6 km, 0.4 mi) because of absence of non-native salmonids. The remaining reaches (T1BA6A to T1BA8; 1.1 km, 0.7 mi) were treated twice until efforts were halted due to the discovery of hybrids in Round Lake.

In the Showers Lake tributary (SLT) reaches between SHW05 and Showers Lake (0.8 km/0.5 miles) were treated with a single pass due to absence of non-native salmonids. Three-pass depletion was conducted on the remaining reaches (SHW09 to SHW05; 1.0 km/0.6 miles). The 3-pass depletion method was conducted three times between SHW08 and SHW05 for a total of nine passes, and only twice on SHW09-SHW08 and SHT00-SHT01 due to weather constraints for a total of six passes. The tributary to the SLT (Figure 1) was not treated above SHT01 because there was no surface water upstream of this point.

Additionally, an informal minnow trapping pilot study was conducted by LTBMU Aquatics Crew between SHW08 and SHW05 during electroshocking treatment in September. The investigation was conducted to evaluate whether minnow traps were efficient in capturing fish in areas that were either too deep, difficult to reach, or otherwise inefficient to electroshock. The study used quarter-inch black vinyl coated steel mesh minnow traps with a 2.54 cm opening. Traps were baited with wet cat food and placed in pools. Twenty-five minnow traps were set in the SLT. Five traps were set for 18 hours between SHW06 and SHW05, 10 traps were set for 20 hours between SHW07 and SHW06, and 10 traps were set for 44 hours between SHW08 and SHW07, for a total of 730 trap hours. Non-native trout were sacrificed and native species were identified and returned to the location in which they were trapped.

In 2013, the LTBMU Aquatics Crew continued removal of non-native salmonids in Dardanelles Lake using gillnets. Lightweight, monofilament gillnets made with six different size meshes (10, 12.5, 18.5, 25, 33, 38 mm) were used. Each panel is 6 m long and 1.8 m deep, making the nets a total of 64 square meters. These are sinking nets designed to maximize the capture of small fish, but effectively capture fish of all sizes. Nets were deployed, using float tubes, around the perimeter of the lake and pulled out toward the deepest areas. A minimum of two crew members were needed for each net set. One crew member would be on shore tying the top of the net to a land anchor, while carefully watching the person in the float tube and recording data. The float tuber would pull the net away from shore, allowing it to flake out into a straight line. Once the net was fully stretched, the person on the float tube would tie off the bottom of the net to a rock to anchor it on the bottom. Parachute cord was tied to the float line and a foam float was attached as a buoy. The net's smallest mesh size was anchored to shore, while the largest mesh size was anchored in deep water, targeting the size class that tends to inhabit each area of a lake. Nets were cleaned starting at the shore end of the net. Nets were pulled up to the float tube for fish and debris to be removed as well as algae to be scrubbed off (cleaner nets are less visible to the fish). Time and date were recorded after each cleaning. Additionally, as nets were cleaned, non-native trout were measured into size classes and species identified (if possible), and sunk into the deepest part of the lake. Nets were cleaned and pulled after the winter of 2012/2013 in June

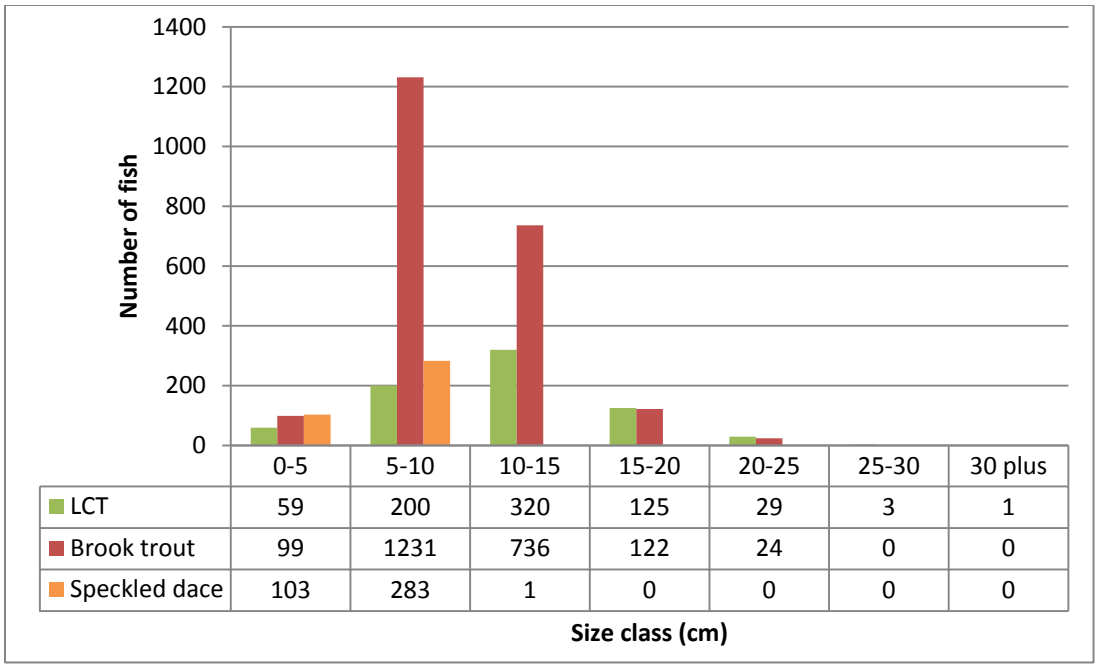
2013, set again in September 2013, and cleaned once in before being set for the 2013/2014 winter season.

In Round Lake, gillnetting was conducted in order to collect genetic samples from LCT to determine if introgression has taken place in the lake population. Field crews followed the same gillnetting methods as previously described, but left gillnets in the water for 1-4 hours to minimize mortality. Genetic samples were obtained by clipping a small piece of fin tissue from the dorsal portion of the caudal fin using clean scissors. Each fin clip sample was placed in a coin-sized manila envelope using tweezers. After every sample, tweezers and scissors were decontaminated with 95% isopropyl alcohol and the alcohol was burned off. Samples were sent to the University of Nevada at Reno laboratory for genetic analysis.

Results

2013 Field Work

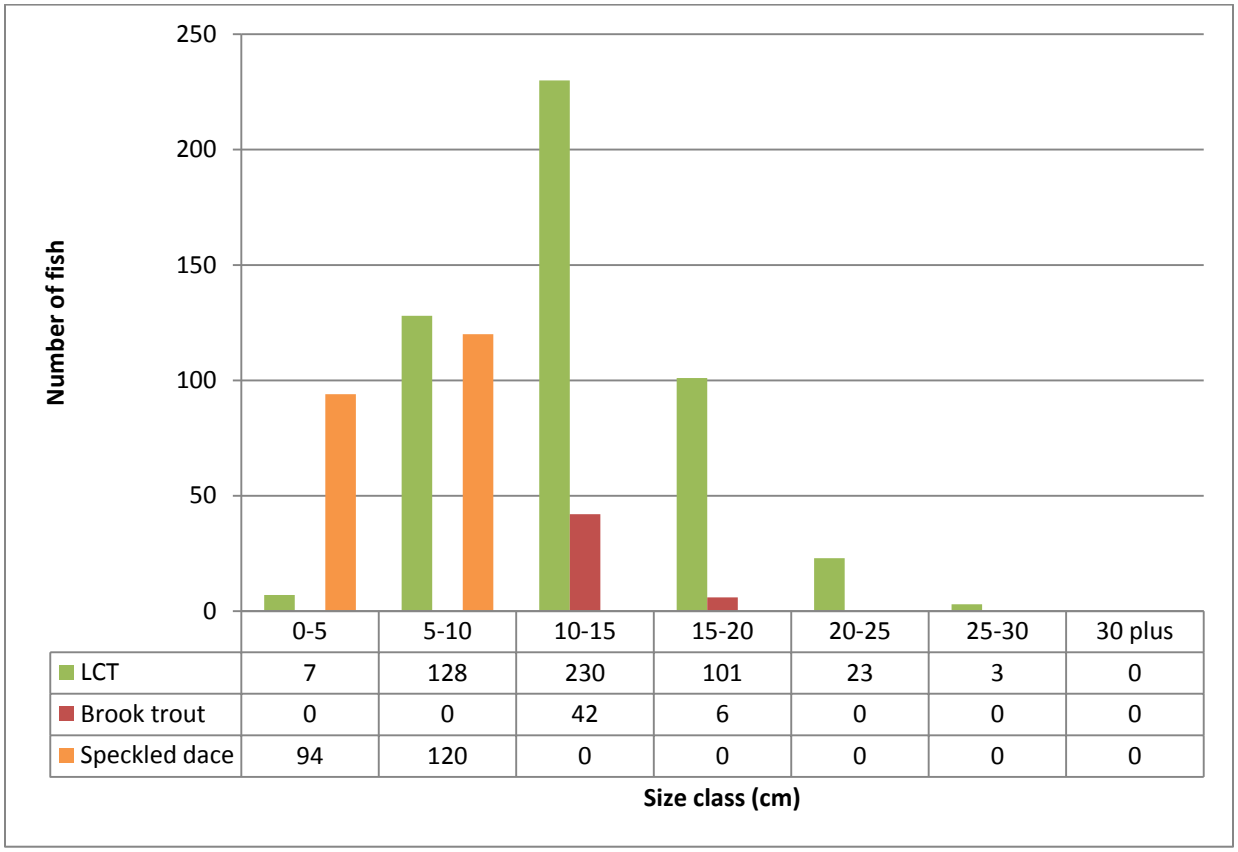
In 2013, non-native trout removal occurred on approximately 6.3 km (3.9 mi) of stream and 7 hectares (18 acres) of lake habitat in the project area, including 2.7 km (1.7 mi) on the mainstem UTR, 1.7 km (1.1 mi) on the RLT, 2.0 km (1.2 mi) in the SLT, and 18 acres of Dardanelles Lake and associated stream. Electro-fishing efforts captured a total of 3,336 fish: 737 LCT, 2,212 brook trout, and 387 speckled dace (Fig. 2). All brook trout and 172 LCT in RLT were manually removed. Incidental mortalities included 17 LCT and 6 speckled dace. Due to multiple treatments of the 3-pass depletion method on the UTR and SLT, it is possible that individual LCT and speckled dace were captured more than once. Total catch of LCT and speckled dace therefore reflects total fish caught, not the number of unique individuals caught in the UTR and SLT. Although there is a lack in confidence regarding the number of LCT in the project area, with the multi depletions (repeated 3-passes), there is an increased confidence in the reduction of non-native trout.



	0-5	5-10	10-15	15-20	20-25	25-30	30 plus
LCT	59	200	320	125	29	3	1
Brook trout	99	1231	736	122	24	0	0
Speckled dace	103	283	1	0	0	0	0

Figure 2. Total number of fish captured through electro-fishing efforts in the expansion area in 2013

Seven hundred fifty-four fish were captured on the mainstem UTR (Fig. 3). Non-native trout removals on the UTR included 48 brook trout. Brook trout were not present in reaches between B39 and FS, and LCT were present in all treatment reaches. Four hundred ninety-two LCT and 214 speckled dace were caught and released back into the river. LCT and brook trout were most abundant in the 10-15 cm size class, with brook trout only caught in the 10-15 cm and 15-20 cm size classes. LCT were caught in all size classes less than 30 cm.



	0-5	5-10	10-15	15-20	20-25	25-30	30 plus
LCT	7	128	230	101	23	3	0
Brook trout	0	0	42	6	0	0	0
Speckled dace	94	120	0	0	0	0	0

Figure 3. Size class distribution of total fish sampled in the UTR in 2013

The 3-pass depletion method was implemented on reaches between B36B and B39 once, with 3 additional passes completed on the reach between B36B and B36A, 4 additional passes completed on the reach between B36A and B37, and 5 additional passes completed on the reach between B37 and B38. The number of brook trout caught decreased after the first pass in these reaches, but there was no change in catch between the second and third pass (Fig.4). Brook trout caught in subsequent passes was not compared because not all reaches were surveyed in all passes.

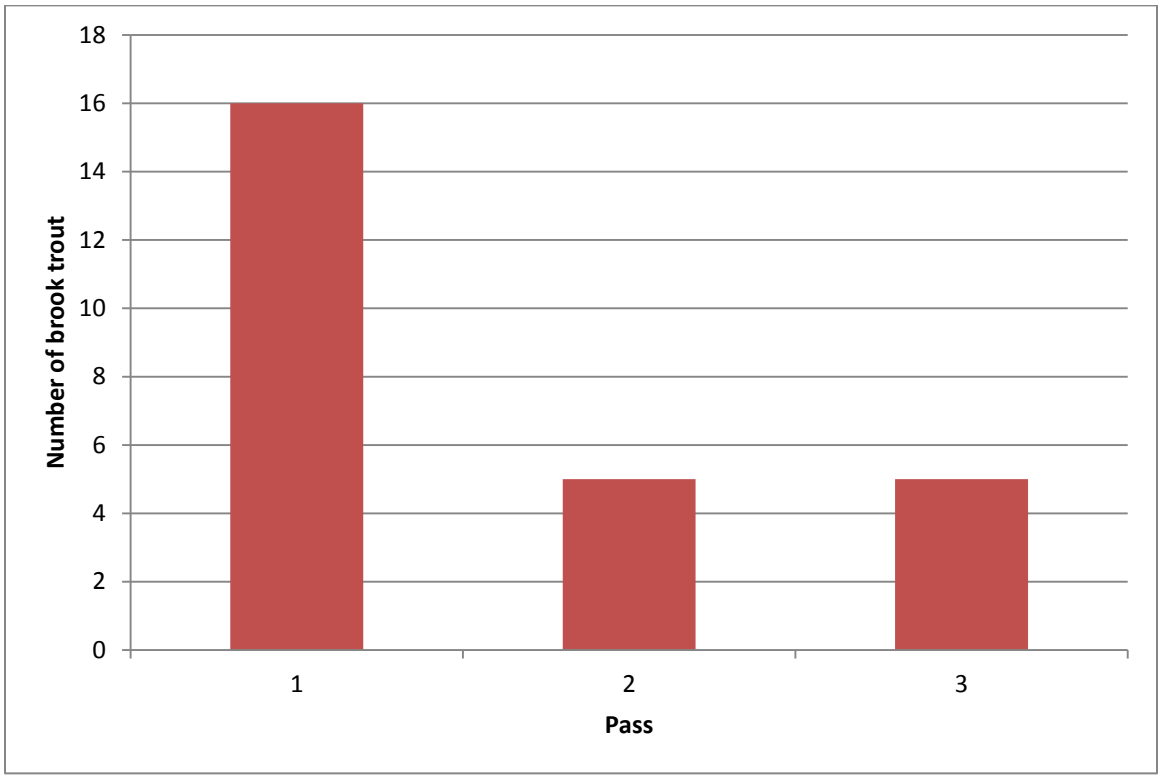
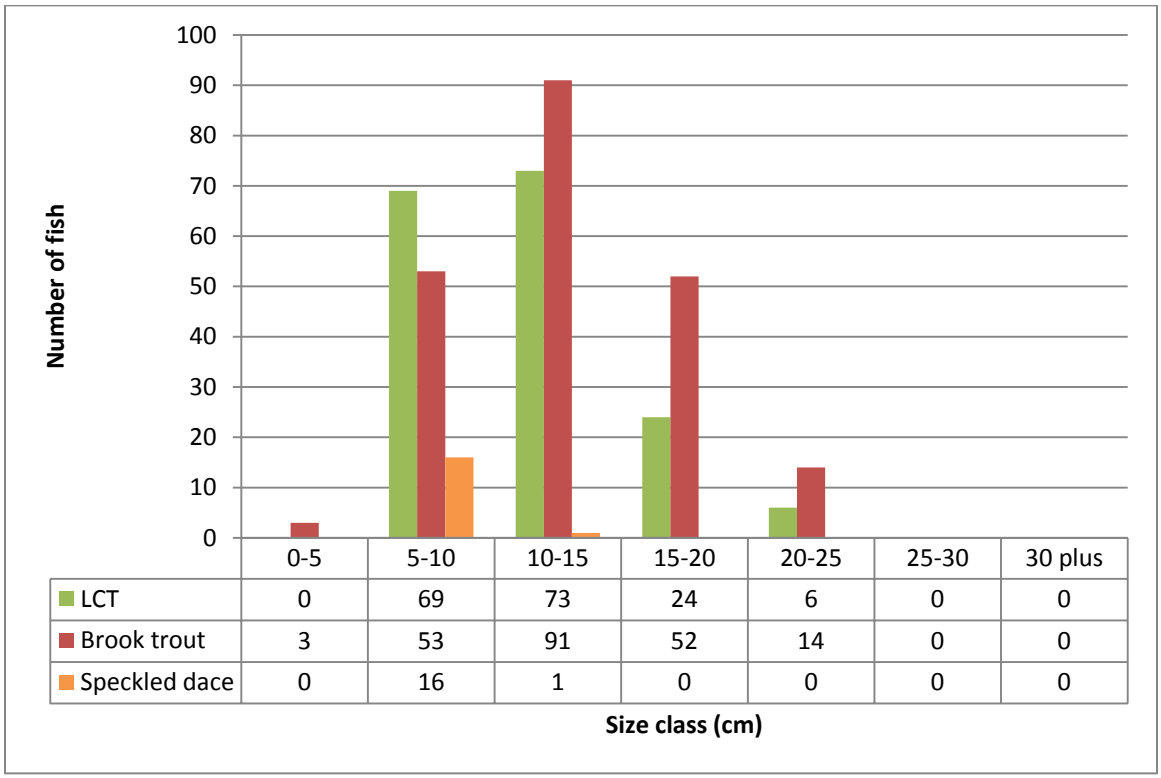


Figure 4. Number of brook trout caught in the first three passes between B36A and B39 on the UTR.

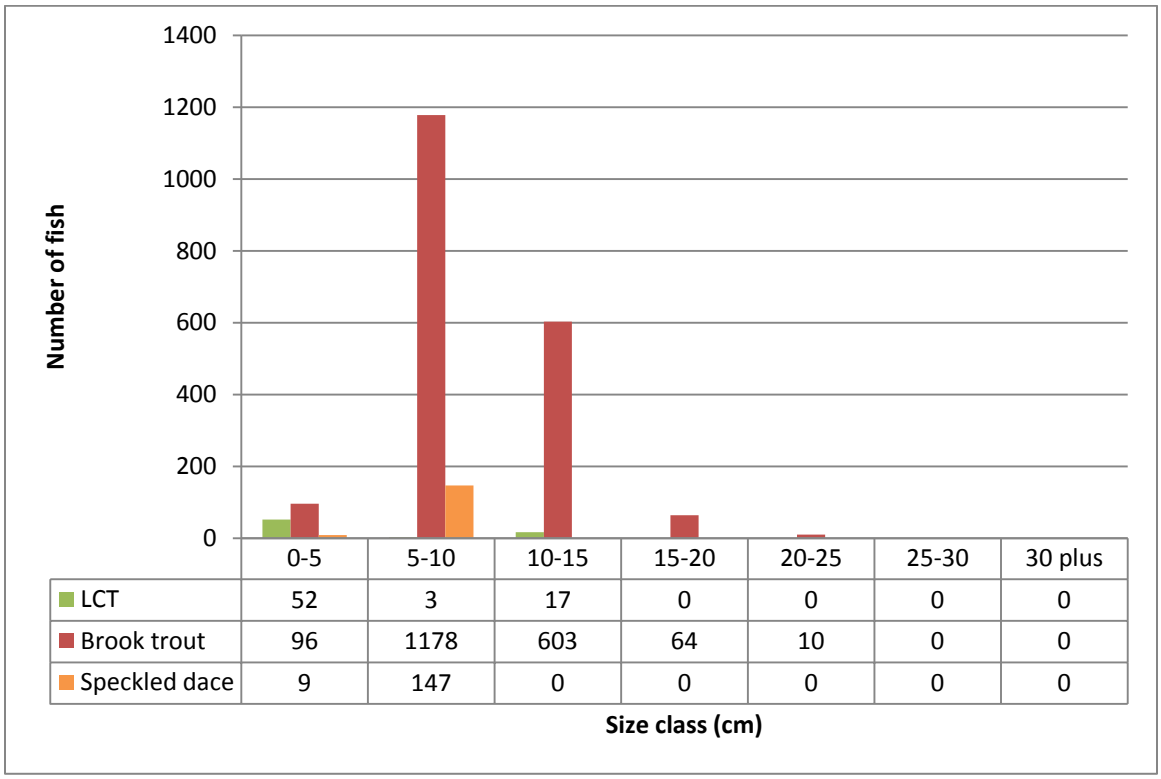
On the RLT, a total of 400 fish were sampled (Fig. 5). Non-native trout removal included 213 brook trout. All 172 LCT caught were sacrificed, and 17 speckled dace were returned to the stream. Between barriers T1BA9 to T1BA10, no fish were sampled because there was no surface water in the reach. LCT were present in all treatment reaches, and brook trout were present only downstream of T1BA7A (Fig.1). LCT were caught in size classes from 5 to 25 cm, and brook trout were caught between 0 and 25 cm. Both species were most abundant in the 10-15 cm size class (Fig.5).



	0-5	5-10	10-15	15-20	20-25	25-30	30 plus
LCT	0	69	73	24	6	0	0
Brook trout	3	53	91	52	14	0	0
Speckled dace	0	16	1	0	0	0	0

Figure 5. Size class distribution of fish sampled in RLT in 2013

A total of 2,180 fish were sampled in the SLT during this first year of treatment. One thousand nine hundred fifty-one brook trout were removed from the drainage, and 73 LCT and 156 speckled dace were released back into the stream (Fig. 6). LCT were caught in size classes 0-5 cm through 10-15 cm with one LCT at 30 plus cm, and brook trout were caught in all but the two largest size classes (Fig. 6).



	0-5	5-10	10-15	15-20	20-25	25-30	30 plus
LCT	52	3	17	0	0	0	0
Brook trout	96	1178	603	64	10	0	0
Speckled dace	9	147	0	0	0	0	0

Figure 6. Size class distribution of total fish sampled in SLT in 2013

Only LCT and speckled dace were caught in the most upstream reaches between SHW02 and Showers Lake, but only speckled dace were caught between SHW04 and SHW02 (Fig. 1). No fish were caught between SHW05 and SHW04 (Fig. 1). Both LCT and brook trout were caught between SHW08 and SHW05, but only brook trout were caught in the most downstream reach between SHW09 and SHW08 (Fig. 1).

Brook trout catch decreased linearly from the first pass through the third pass in the SLT (R^2=1.00; Fig. 7). More fish were caught in pass 4 than in pass 3. Pass 4 was completed 3 days after pass 3, whereas passes 1, 2, and 3 were completed in the same day or successive days. Subsequent passes were not conducted ubiquitously on the SLT, and are therefore not compared with the first 3 passes.

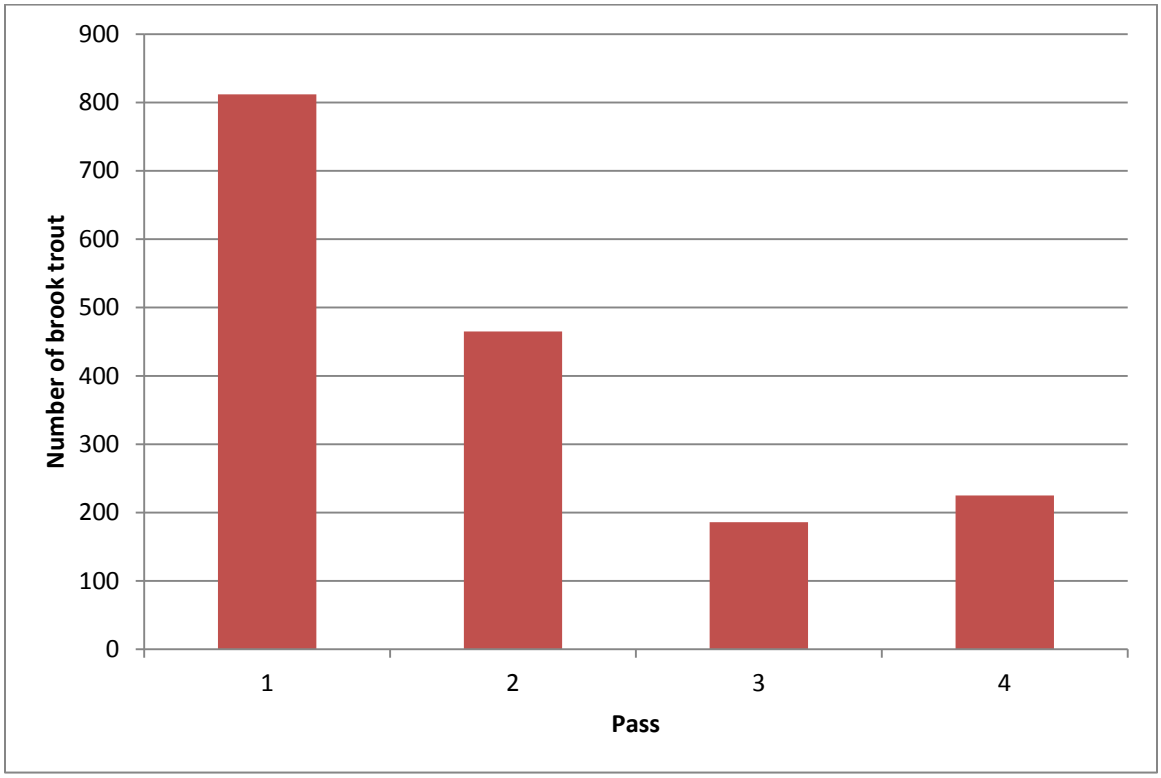


Figure 7. Number of brook trout caught in the first 4 passes in the entire SLT

The 11 gillnets set in Dardanelles Lake from October 2012 were cleaned and removed in June 2013. The field data sheet with gillnet sampling results was lost, but an estimated 25 brook trout were caught. Six gillnets were set at the end of September, and were cleaned once after 24 hours before being over-wintered. A total of 7 brook trout were caught in this 24 hour set.

Four 10-15 cm brook trout were caught over the 730 hours of minnow trapping, for a catch per unit effort (CPUE) of 0.16 fish.

2013 Genetic Information

Genetic results analyzed by University of Reno, NV Laboratory (genetics lab) from the 2012 field season were received in 2013. Results were received on May 14, 2013 from Veronica Kirchoff. No hybrids were found between B35A and B41 on the UTR. On RLT, 4 of the 60 individuals sampled between T1BA1 and T1BA9 showed low level introgression (1 rainbow trout allele). These hybrids were located in reaches T1BA3-T1BA4, T1BA4-T1BA6A, and T1BA8-T1BA9 (Fig. 1).

Genetic samples were collected from 53 individuals in Round Lake in August 2013. Results were provided by University of Reno Laboratory on August 20, 2013 from Jason Smith. Results indicated low level introgression (1 rainbow trout allele) in 2 of the 53 individuals sampled. All treatment on RLT was halted after this finding due to the potential for hybrids to travel into the RLT from Round Lake during high flows.

2008 - 2013 Progress

A total of 18.3 km (11.4 miles) of river have been treated since 2008 (Table 1).

Table 1. Kilometers treated per year for each river segment

Year	UTR (13.0 km total)		RLT (8.6 km total)		SLT (2.0 km total)	
	Distance (km)	Reaches	Distance (km)	Reaches	Distance (km)	Reaches
2008	1.0	B38-B42	--	--	--	--
2009	2.7	B36C-FS	--	--	--	--
2010	5.3	B28-B41	2.3	T1BA9-T1BA6, T1BA4-T1BA1	--	--
2011	2.6	B33-B41	3.1	T1BA10-T1BA1	--	--
2012	2.1	B35-B41	3.1	TIBA10-T1BA1	--	--
2013	2.7	B36B-FS	1.7	T1BA10-T1BA6A	2.0	SHW01-SHW09

LCT have been caught in all treatment reaches of the UTR since 2008. Since 2011, no brook trout have been documented between B39 and B41. Additionally, brook trout were not present in reaches monitored above B39 in 2013.

For the rest of this section, annual comparisons in the UTR are made between the total numbers of fish caught in the first 3 passes. Three-pass depletion was performed multiple times in 2013, and therefore the same individuals may have been counted twice. Because the goal of the project is to eradicate non-native trout to recover LCT, this lack of confidence in exact LCT numbers is acceptable. In order to compare across years only the numbers of fish caught in the first 3-pass treatment in 2013 will be compared with former years, so that trends can be more clearly displayed. Additionally, although corresponding areas were surveyed in 2008 and 2009, reaches were not delineated the same and 3 passes were not completed in all areas. Therefore, total catch from these years will not be compared with latter years.

The reaches between B36B and B41 in the UTR can be compared from 2010 to 2013. LCT catch increased linearly in these reaches from 2010 to 2012 (R^2=0.97), and decreased from 2012 to 2013 (Fig. 8). Brook trout catch between B36B and B41 has shown no trend from 2010 to 2013 (Fig. 8), but total catch of LCT in these reaches continues to be higher than total catch of brook trout each year.

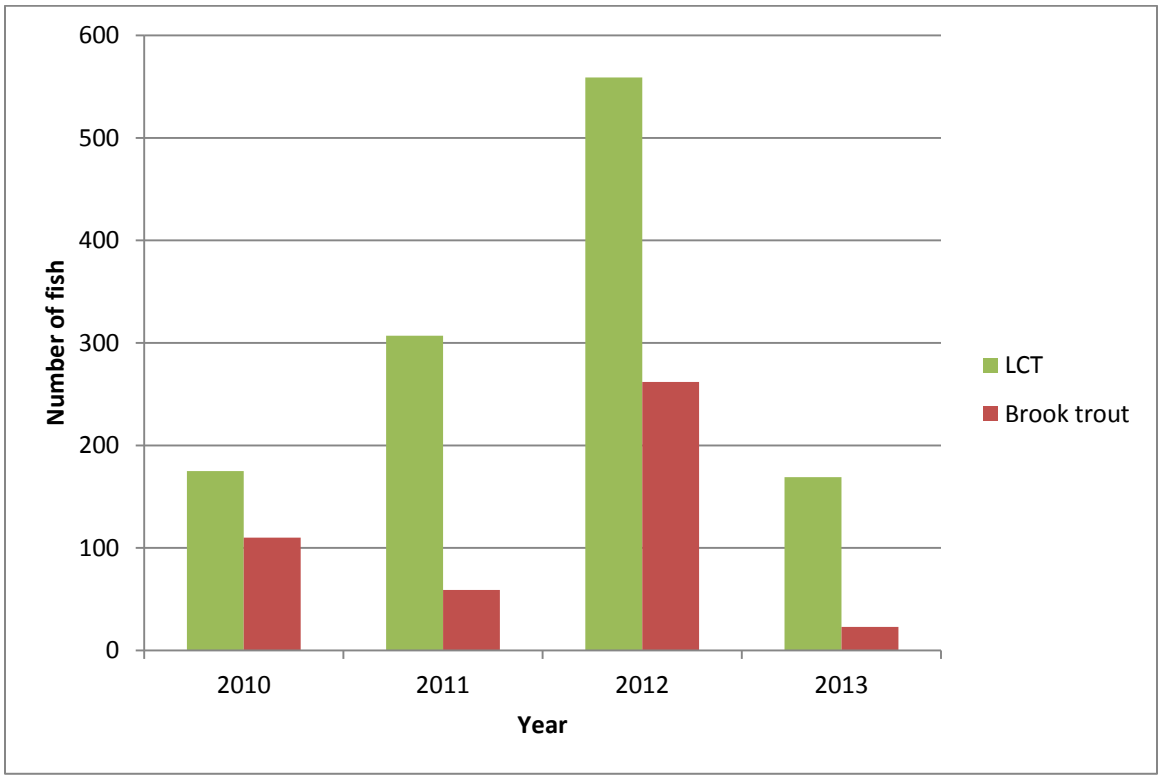


Figure 8. Number of LCT and brook trout caught in the first 3-pass treatment in the UTR reaches B36B through B41 from 2010-2013

Numbers of LCT in the smaller size classes (0-5 cm, 5-10 cm, and 10-15 cm) all increased from 2010 to 2012 and decreased from 2012 to 2013 in the UTR (Fig. 9). Brook trout in the 20-25 cm size class decreased from 2008 to 2013, with zero brook trout caught greater than 20 cm in 2013 (Fig. 10).

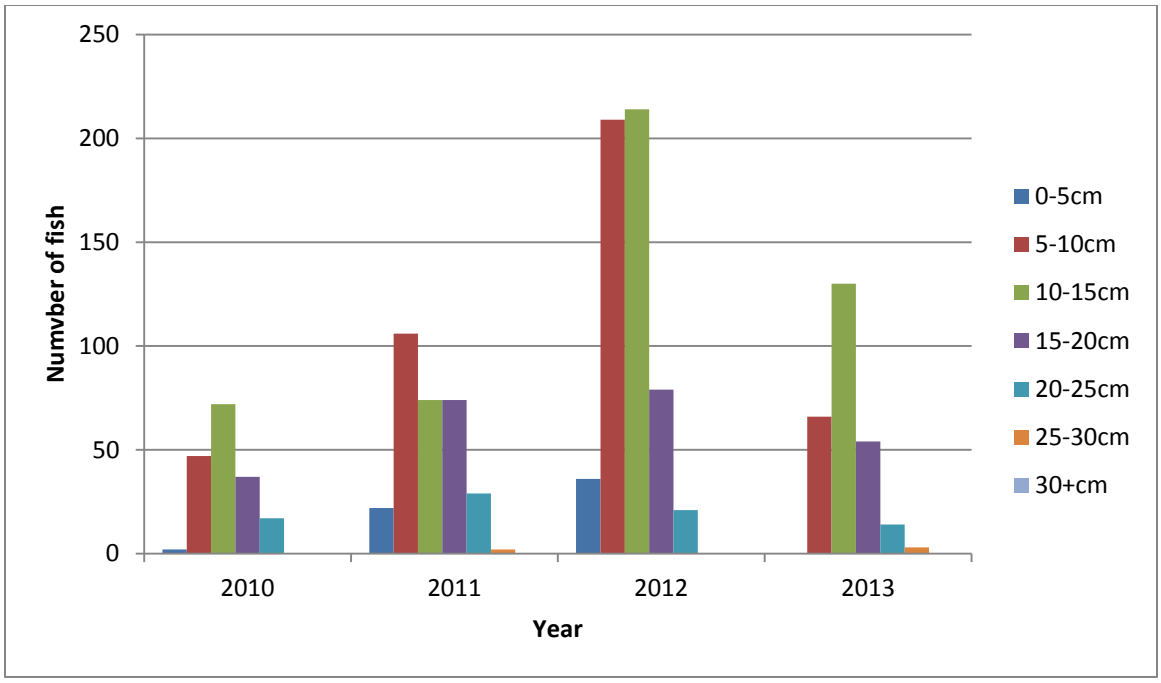


Figure 9. Number of LCT caught in the first 3-pass treatment in each size class per year in the UTR reaches B36B through B41

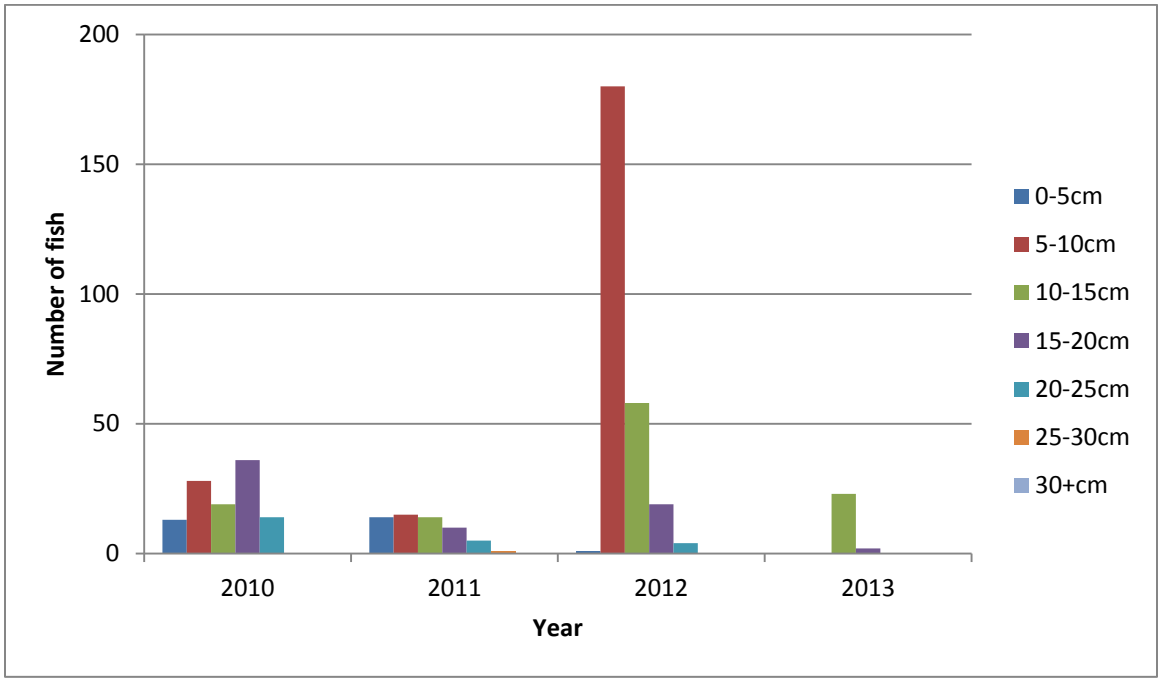


Figure 10. Number of brook trout caught in the first 3-pass treatment in each size class per year in the UTR reaches B36B through B41

The number of brook trout and LCT caught in RLT between T1BA6A and T1BA10 from 2010 to 2013 is displayed in Figure 11. Three passes were not completed in every year of treatment, making comparisons of total catch across years problematic. A comparison of just the first pass completed each year shows a similar trend to Figure 11.

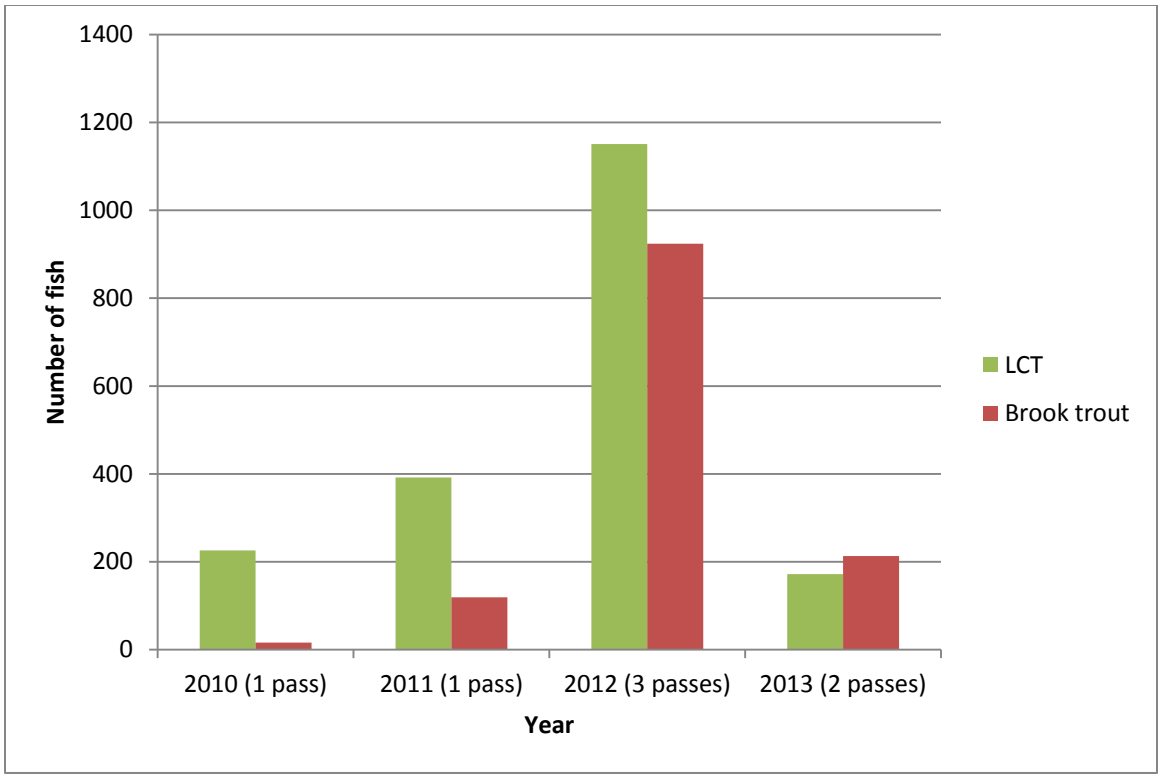


Figure 11. Number of LCT and brook trout caught in RLT between T1BA6A and T1BA10 from 2010-2013

Since treatment started in RLT, no fish have been caught above T1BA9 (Fig. 12). Additionally, no brook trout have been caught between T1BA8 and T1BA9. Only a total of 23 brook trout were been caught between T1BA6 and T1BA8 in 2012 and 2013 (Fig. 13). Ninety eight percent of all brook trout and 50 percent of all LCT caught above T1BA6A from 2010 to 2013 were caught in T1BA6A to T1BA6 (Figs. 12 and 13).

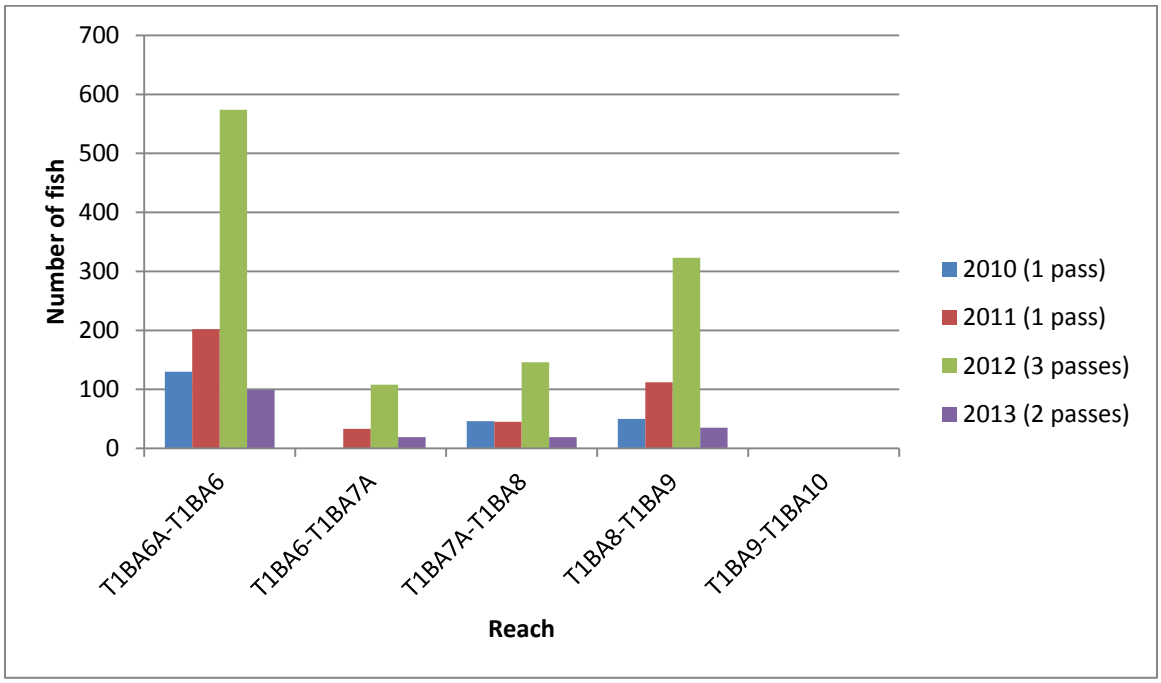


Figure 12. Number of LCT caught in RLT from 2010-2013 by reach

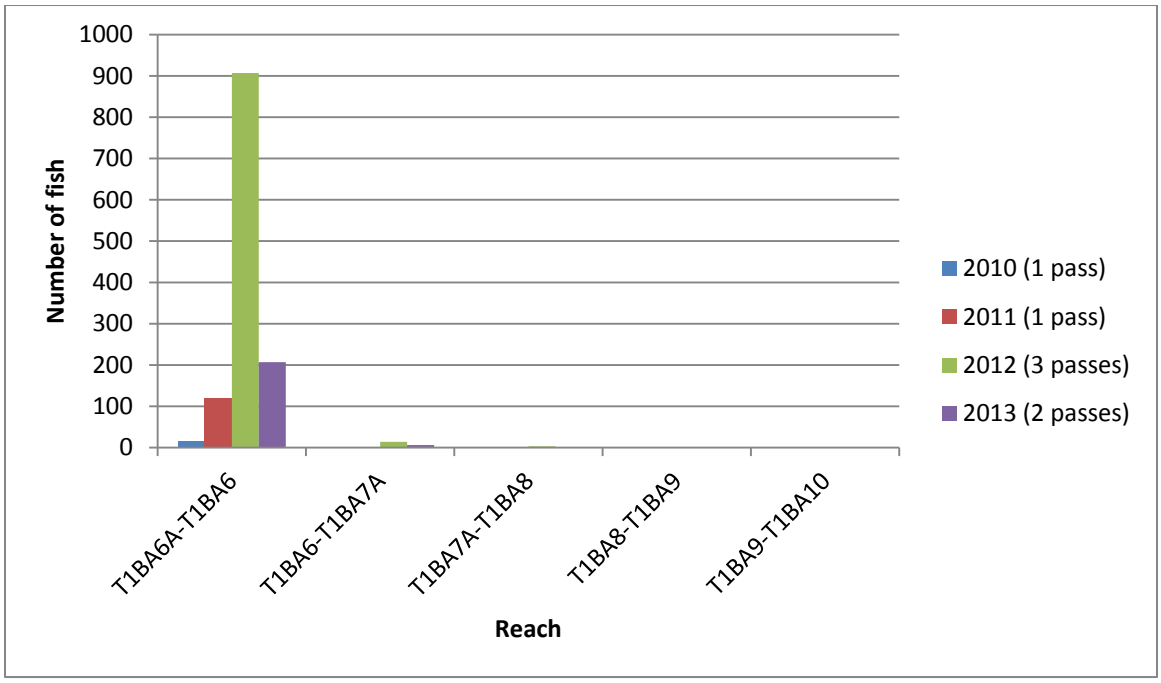


Figure 13. Number of brook trout caught in RLT from 2010-2013 by reach.

As previously stated, there are problems comparing catch between years in RLT because of the inconsistent application of the 3-pass depletion method. However, it is apparent that in 2013 none of the smallest size class (0-5 cm) were documented for LCT (Fig. 14). Otherwise, there does not seem to be much change in size class structures for LCT or brook trout since 2010 (Figs. 14 and 15).

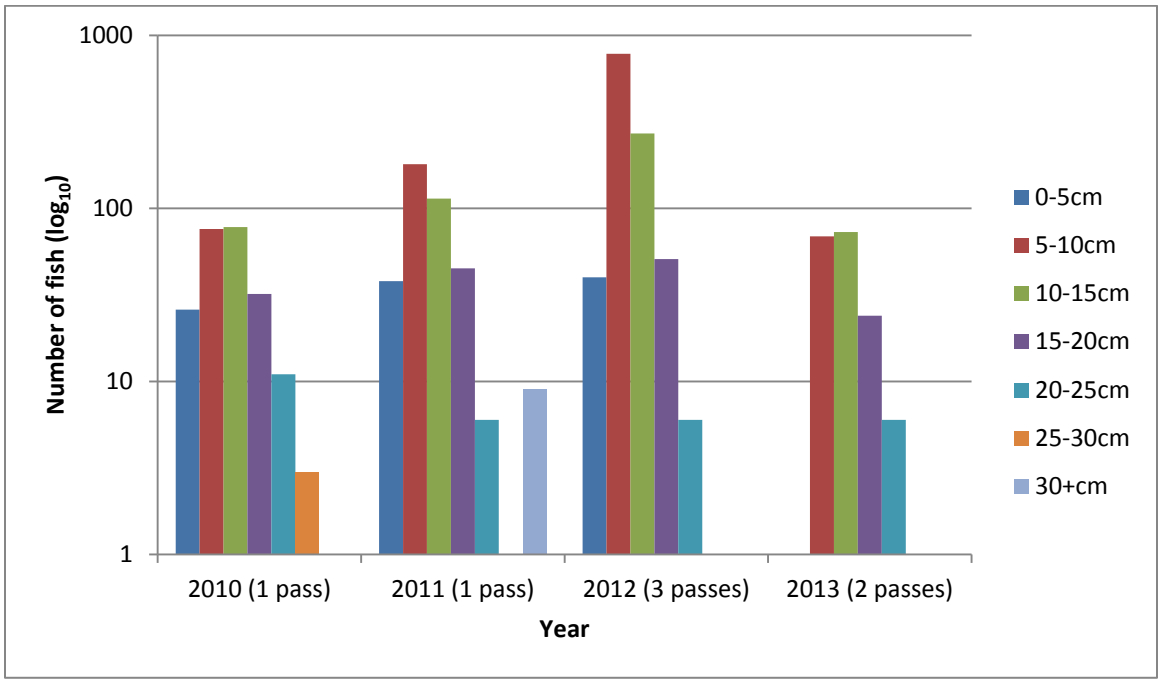


Figure 14. Number of LCT caught in each size class per year in RLT between T1BA6A and Round Lake

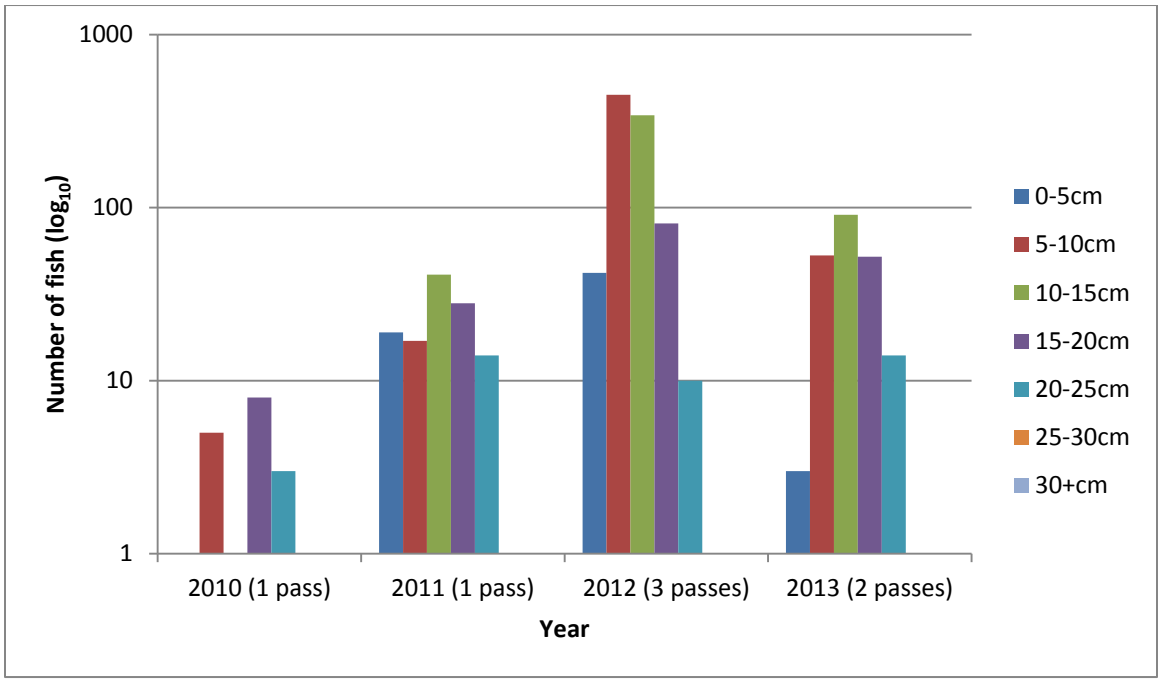


Figure 15. Number of brook trout caught in each size class per year in RLT between T1BA6A and Round Lake

Catch from the first set of gillnetting in Dardanelles Lake in 2012 caught 212 brook trout (Fig. 16). Gillnets set over winter 2012/2013 caught an estimated 25 brook trout, and 7 brook trout were caught in the first gillnet set of 2013. This amounts to an overall reduction in catch of 97 percent from the start of gillnetting in 2012 to the most recent nets set in 2013. Note that not all nets were used in each set, and each set spanned a different amount of time (Fig.16).

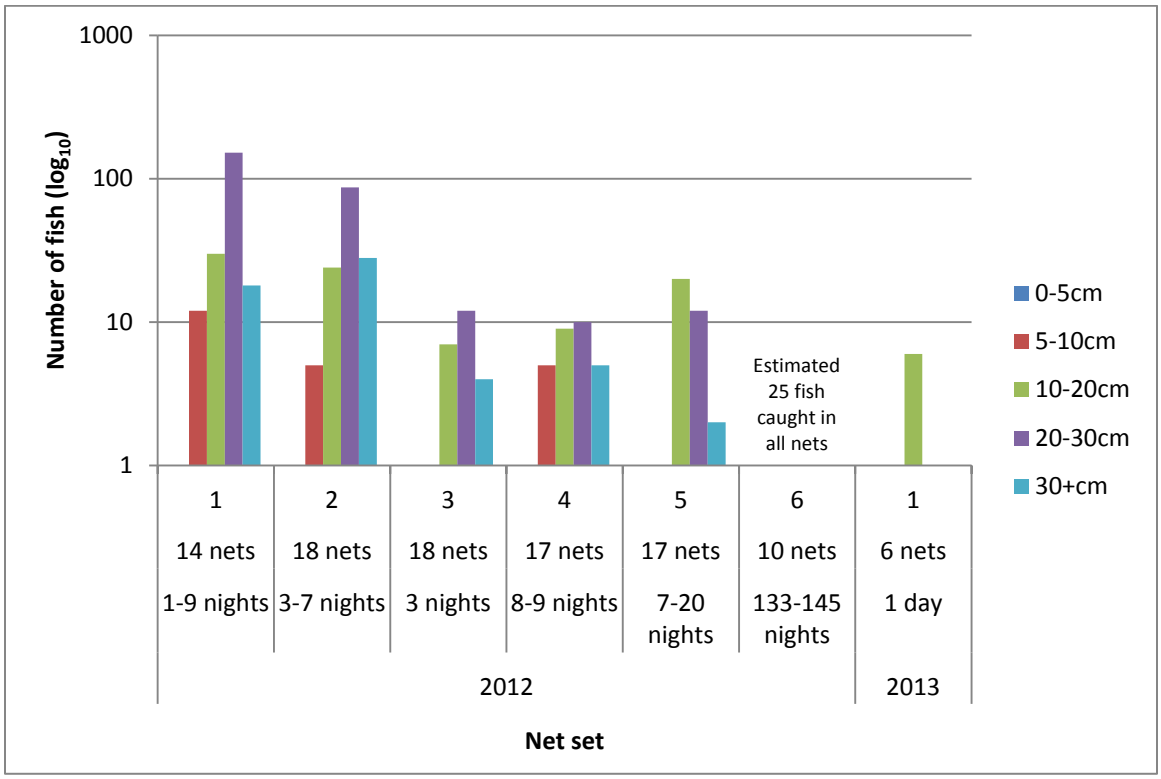


Figure 16. Size class distribution of brook trout caught in 2012 and 2013 in Dardanelles Lake

Discussion

Since the start of restoration in 2008, no brook trout have been documented in the reaches between B41 and FS. In 2013, reaches on the UTR between B39 and B41 were surveyed and had no detections of brook trout. These surveys confirmed no brook trout within the reaches for the third year. This indicates success in the project objectives, as 0.6 km (0.4 mi) of stream has been added to the LCT population area that is now free of non-native fish. Data from 2013 indicate that the upper 1.0 km (0.6 mi) of the RLT between T1BA7A and Round Lake as well as the upper 0.8 km (0.5 mi) of the SLT between SHW05 and Showers Lake are also both clear of brook trout.

Due to the unintended consequences of electro-fishing, including unintended mortalities and deformations, stream reaches with three consecutive years of no non-native fish detected are rested until project effectiveness monitoring is initiated. Therefore, 2014 treatment will not occur above B39 on the UTR. Treatment will continue on all reaches of the SLT for the next 2 years before any reach can be designated free of non-native fish. Lastly, although no brook trout have been noted above T1BA8 in RLT since the start of treatment in 2010, LCT hybrids with rainbow trout are still present throughout the tributary as well as in Round Lake. This indicates the

potential for hybrids to travel downstream from Round Lake in extremely high water years. This resupply of hybrids to the RLT means obtaining pure genetic LCT in RLT may be ineffective unless hybrids as well as the potential for hybridization are removed from Round Lake. RLT was surveyed two times throughout the field season to determine the status of natural barriers and identify locations for temporary barrier enhancement to aid in future removal efforts. Coordination meetings between CDFW, USFWS, and USFS were held on July 29, 2013, August 29, 2013, and November 13, 2013. Prior to continuing recovery efforts on RLT, downstream barriers will need enhancement, a removal plan will need to be drafted and approved by partner agencies, and a projected budget and timeline will need to be developed.

During the 2013 field season, LCT were detected consistently in all treatment reaches of the UTR and RLT. More LCT were present in the upper reaches when compared to the lower reaches of the UTR, likely because the area is downstream of the Meiss Meadow reclamation area where a self-sustaining population of LCT exists, and because of removal of brook trout in the upper reaches since 2008 creating an absence of the species above B39. The same reasoning may explain why LCT were the only salmonid present in the most upstream reaches of the RLT; LCT were intermittently stocked by CDFW in Round Lake between 1955 and 2008, and brook trout were removed in RLT in previous years. LCT presence was not consistent in the entire Showers Lake outlet tributary, likely due to the fish passage barriers, lack of sufficient habitat in certain reaches, and the absence of non-native fish removal in previous years. However, LCT were the only salmonid present above SHW02, likely because LCT were stocked intermittently in Showers Lake between 1997 and 2012. It should be noted that there is not an inlet stream into Showers Lake that could provide spawning habitat.

Throughout the expansion area, LCT were found in several size classes. This suggests suitable spawning habitat is available in the system, reproduction is occurring, and LCT may thrive in the expansion area when competition with and predation from brook trout is eliminated. This theory is supported by the increase in LCT in the upper reaches of the UTR in the expansion area from 2008 through 2012.

Three-pass depletion in B36A through B39 on the UTR did not show a continuous decrease in catch of brook trout, likely due to the low numbers of brook trout present in the surveyed reaches at the start of the treatment. This indicates that as brook trout eradication efforts continue, it may become more difficult to remove the final individuals from a given reach or section of river using electroshocking methods. In the SLT catch decreased linearly until the fourth pass, where catch increased. This was likely due to the amount of time elapsed between the third and fourth pass, indicating that letting the stream rest between electroshocking passes may allow for greater recovery and capture of previously electroshocked but not captured fish.

Fewer numbers of fish were sampled in 2013 in the UTR and RLT as compared to 2012, even with multiple sets of 3-pass depletion on the UTR. Water levels in the UTR mainstem were high in 2011 and extremely low in 2012 and 2013. In low water years, fish may move downstream to find refuges where more water is present, habitat suitable for reproduction is reduced upstream, and there may be more natural passage barriers to upstream migration as water levels drop. Low water levels also created minimal shockable habitat in the reaches, as well as small disconnected pools where water temperatures increased throughout the season. Water temperatures above

13.3°C can result in major mortality for LCT eggs, and adults experience high mortality above 26.0°C (Gerstung 1988, Dickerson and Vinyard 1999). Although temperature data are not recorded during electroshocking treatment because of time restraints, there is a permanent temperature logger located upstream of the expansion area in Meiss Meadows. It may be useful to compare temperature readings from this logger in the future to see if there is any correlation with changes in salmonid abundance.

Since 2012 there has been a decrease in brook trout young of year and the largest adult brook trout in the UTR, indicating that eradication efforts may be effectively removing spawning brook trout from the system. It will be useful to look for a pattern in years to come to determine whether these changes are truly a result of eradication efforts or whether they are a result of other environmental factors.

It is difficult to compare RLT data over the project years because only 1 pass was completed in 2010 and 2011, 3 passes were completed in 2012, and 2 passes were completed in 2013. Additionally, in some years the upper reach (T1BA9 upstream to Round Lake) of the stream was dry, as in 2012 and 2013. It does appear as though there is a reduction in brook trout and LCT young of year from 2012 to 2013, potentially due to eradication efforts of both species. However, low water levels and temperature may also be impacting fish abundance in RLT.

Dardanelles Lake was stocked with brook trout intermittently between 1950 and 2000. In 2013, Dardanelles Lake was gillnetted for the second year in an effort to remove brook trout. Although half the number of nets was set in 2013 than in 2012, the high reduction in catch indicates gillnetting efforts in Dardanelles Lake are reducing brook trout numbers. A decline in the largest and smallest size classes caught (30 plus cm and 5-10 cm) indicates that gillnetting efforts may be eliminating the minimal amount of spawning that was occurring in Dardanelles Lake prior to gillnetting treatment. This removal effort is eliminating the potential downstream movement of brook trout into the UTR and RLT.

The minnow trapping initiated in September 2013 was an effort to utilize all methods possible in order to accelerate non-native species eradication. Although catch rates were not high at 0.16 CPUE, the minnow traps were set after reaches had already been treated with 5 or 6 passes. For comparison, the 6th electroshocking pass on SHW06 caught 10 brook trout, SHW07 caught 1 brook trout, and SHW08 caught 13 brook trout. These numbers were a great reduction from the first passes on each reach, which caught 276, 140, and 290 brook trout, respectively. Although no direct conclusions can be drawn from this first year utilizing minnow traps, as data collection was minimal, it is possible that setting minnow traps earlier next season before many of the brook trout are removed by electroshocking may result in higher CPUE. Additional years of minnow trapping implementation may also help to determine whether utilizing minnow traps reduces the amount of effort needed by electroshocking, and whether more fish are caught with minnow traps in areas that are hard to reach with a backpack electroshocker.

Conclusion

The LTBMU will continue to pursue the recovery objectives for LCT in coordination with partners. Recovery efforts will continue in the UTR Expansion Area as follows:

- Continue removal efforts in the UTR from B36A to B39
- Rest (no treatment) in the UTR from B39 to B41
- Continue treatment of SLT from SHW00 to SHW09
- Continue utilzing minnow traps in SLT and initiate use in UTR
- Install additional temperature loggers in project area
- Continue coordination with USFWS and CDFW to develop a Removal Plan for RLT. Removal plan should include:
    - Location of existing barriers and where barriers are needed to effectively and effiently removal non-desirable fish.
    - Expected timeline to complete removal from T1BA10 to T1BA1
    - Expected timeline to complete removal in Round Lake
    - Budget

Literature Cited

Betolli, P.W.; Maceina M.J.; Noble, R.L.; Betsill, R.K. 1992. Piscivory in largemouth bass as a function of aquatic vegetation abundance. North American Journal of Fisheries Management. 12: 509-516.

Carey, M.P.; Sanderson, B.L.; Friesen, T.A.; Barns, K.A.; Olden, J.D. 2011. Smallmouth bass in the Pacific Northwest: a threat to native species; a benefit for anglers. Reviews in Fisheries Science. 19(3): 305-315.

Cordone, A.J.; Frantz, T.C. 1968. An evaluation of trout planting in Lake Tahoe. California Fish and Game 54 (2): 68-89.

Dickerson, B.R.; Vinyard, G.L. 1999. Effects of high chronic temperatures and diel temperature cycles on the survival and growth of Lahontan cutthroat trout. Transactions of the American Fisheries Society. 128: 516-521.

Dunham, J.; Peacock, M.; Rieman, B.; Schroeter, R.; Vinyard, G. 1999. Local and geographic variability in the distribution of stream-living Lahontan cutthroat trout. Transactions of the American Fisheries Society. 128: 875-889.

Fausch, K.D. 1989. Do gradient and temperature affect distribution of, and interactions between, brook char (*Salvelinus fontinalis*) and other resident salmonids in streams? Physiological Ecology. 1: 303-322.

Findlay, C.; Bert, D.; Zheng, L. 2000. Effect of introduced piscivores on native minnow communities in Adirondack lakes. Canadian Journal of Fisheries and Aquatic Sciences. 57(3): 570-580.

Gerstung, E.R. 1986. Fishery management plan for Lahontan cutthroat trout (*Salmo clarki henshawi*) in California and western Nevada waters. Inland Fisheries Administration Report No. 86. Federal Aid Project No. F33-R-11. Sacramento, CA: California Deptartment of Fish and Game: 53 p.

Gerstung, E.R. 1988. Status, life history, and management of Lahontan cutthroat trout. American Fisheries Society Symposium. 4: 93-106.

Gresswell, R.E. 1988. Status and management of interior stocks of cutthroat trout. American Fisheries Society Symposium, volume 4.

Griffith, J.S. 1988. A review of competition between cutthroat trout and other salmonids. American Fisheries Society Symposium 4: 134-140.

Hilderbrand, R.H. 1998. Movements and conservation of cutthroat trout. Logan, UT: Utah State University. 135 p. PhD dissertation.

Kamerath, M.; Chandra, S.; Allen, B.C. 2008. Distribution and impacts of warm water invasive fish in Lake Tahoe, USA. Aquatic Invasions 3(1): 35-41.

MacRae, P.S.D.; Jackson, D.A. 2001. The influence of smallmouth bass (*Micropterus dolomieu)* predation and habitat complexity on the structure of littoral zone fish assemblages. Canadian Journal of Fisheries and Aquatic Sciences 58: 342-351.

Moyle, P.B. 2002. Inland Fishes of California. Berkeley, CA: University of California Press. 517 p.

Moyle, P B.; Nickols, R.D. 1973. Ecology of some native and introduced fishes of the Sierra Nevada foothills in central California. Copeia. 3: 478-490.

Murphy, D.D.; Knopp, C.M. 2000. Lake Tahoe watershed assessment. Gen. Tech. Rep. PSW-GTR-175-176. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Schroeter, R.E. 1998. Segregation of stream dwelling Lahontan cutthroat trout and brook trout: patterns of occurrence and mechanisms for displacement. Reno, NV: University of Nevada. 186 p.

NMFS (National Marine Fisheries Service). 2000. Guidelines for electro-fishing waters containing salmonids listed under the Endangered Species Act. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 5 p.

Erman, D.C., ed. 1997. Status of the Sierra Nevada: the Sierra Nevada ecosystem project. DDS-43. U.S. Department of the Interior, Geological Survey; University of California Riverside, Center for Water Resources; U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

USDA (U.S. Department of Agriculture). 1988. Land and resource management plan for the Lake Tahoe Basin Management Unit. U.S. Department of Agriculture, Forest Service, Pacific Southwest Region.

Vander Zanden, J.; Chandra, S.; Allen, B.C.; Reuter, J.E.; Goldman, C.R. 2003. Historical food web structure and restoration of native aquatic communities in the Lake Tahoe (California-Nevada) basin. Ecosystems. 6: 274-288.